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ABSTRACT

A report by Crawford found substantial correlations between hypnotizability and various speed-of-closure measures. An attempt to replicate these correlations on the same population of university undergraduates in the present study yielded markedly lower correlations. Nonproportional sampling techniques may have spuriously inflated the earlier reported correlations. Subsequent attempts to correct these correlations for the biases introduced by nonproportional sampling led to the development of a new technique to correct an inflated correlation. This procedure empirically modifies the distribution of scores to reflect the normative distribution, and has implications for correlational research using nonproportional or extreme groups designs. It appears that there is a relationship between hypnotizability and speed of closure, though not of the magnititude suggested by Crawford. (Author/VT)

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THE RELATIONSHIP BETWEEN HYPNOTIZABILITY AND SPEED OF CLOSURE

DAVID F. LOHMAN

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Many trait theorists have argued against the artificial separation of ability and personality constructs. Hilgard contends that hypnotizability is a personality construct. Until recently, however, attempts to relate hypnotizability to other personal characteristics have yielded negative or inconclusive results. Thus, a report by Crawford of substantial correlations between hypnotizability and various speed-of-closure ability measures signalled an important breakthrough. An attempt to replicate those correlations on the

same population in the present study yielded markedly lower correlations. It is argued that non-proportional sampling techniques spuriously inflated the earlier reported correlations. Subsequent attempts to correct these correlations for the biases introduced by non-proportional sampling led to the development of a new technique to correct an inflated correlation. This procedure empirically modifies the distribution of scores to reflect the normative distribution. Implications of these techniques for correlational research using nonproportional or extreme groups designs are discussed. Finally, the relationship between hypnotizability and speed of closure is examined in the light of the corrected coefficients, and implications for future research are outlined.

PREFACE

The investigation reported herein is part of an ongoing research project aimed at understanding the nature and importance of individual differences in aptitude for learning. Information regarding this project and requests for copies of this or other technical reports should be addressed to:

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Beginning with Benet (see Wolf, 1973), numerous investigators have argued against the convenient, but artificial distinction between ability and personality constructs (Wechsler, 1958; Thurstone, 1944; Anastasi, 1967; Cronbach & Snow, 1977). There is now a large literature attesting to relationships between these two domains. Witkin's research on field independence is one good example of work that elaborates combined constructs (see, e.g., Witkin et al., 1962). Similarly, Smith (1964) summarizes a large number of studies on the relationships between spatial ability and various personality constructs. More recent ATI studies have also found numerous interactions between ability and personality constructs, and shown that their combination may be important in predicting learning outcomes in some instructional settings (Cronbach & Snow, 1977; Snow, 1976a).

But research seeking to explore such combinations faces a myriad of personality constructs based largely on work with multiscale self-report questionnaires. Many of these personality constructs are of doubtful validity and stability over time and situations, and there is as yet no agreed-upon theoretical model for organizing them comparable to that available for the ability domain. The best exploratory strategy for the present would seem to be to identify those few personality constructs that seem reasonably stable, adequately measured by multiple methods, and relevant at least conceptually to ability and learning constructs. Then, the approach used by Witkin, Smith, and others, of pursuing the various personality correlates of one stable ability construct, could also be applied in reverse; the various ability and learning correlates of such constructs could be elaborated, and the kinds of situations where they might be most relevant could be better judged.

Only a few personality constructs seem to be candidates for such treatment. One is anxiety, as pursued in the work of Spielberger (see, e.g., Gaudry & Spielberger, 1971). Another would be Eysenck's (1966) research on extraversion-introversion and neuroticism. A beginning in this direction has also been made on a construct called achievement via independence vs. achievement via conformity (Domino, 1971; Snow, 1976a, b).

Another construct worth consideration in this connection is hypnotic susceptibility. Hilgard (1968) regards hypnotic susceptibility as a

central, stable personality characteristic, and there has been a continuing search for correlations between measures of it and ability variables. Early results have been largely negative, however, (see Hilgard, 1968). Thus Crawford's (1976) recent demonstration of strong correlations between various speed of closure tests and hypnotic susceptibility measures represents an important advance.

Crawford (1976) reported correlations between the Stanford Hypnotic Susceptibility Scale: Form C (SHSS:C; Weitzenhoffer & Hilgard, 1962) and several cognitive tests. Of particular interest were the correlations with several closure tests, i.e., Closure Speed (Thurstone & Jeffrey, 1956), Street Gestalt Completion (Street, 1931) and Harshman Figures (Harshman, 1974). Two spatial ability tests (Paper Form Board; Surface Development), a verbal reasoning test (Nonsense Syllogisms) and a flexibility of closure test (Hidden Figures) were also included in her reference battery, all of which were drawn from the ETS Kit of Reference Tests for Cognitive Factors (French, Ekstrom & Price, 1963).

Crawford's correlation between SHSS:C and the sum of the three speed of closure tasks was .60 for males (N=22), .49 for females (N=20) and .56 for the total group (N=42). The only other significant correlation occurred between Paper Form Board and SHSS:C for females (r=.39, N=20). The other three cognitive tests did not correlate significantly with SHSS:C.

The hypothesis implicit in this research is that hypnotizability is related to right cerebral hemisphere abilities or at least to a stylistic preference for right hemisphere processing. Evidence for right hemisphere involvement in tests that measure speed of closure derives primarily from investigations of brain damaged and split-brain patients. Several studies have shown that patients with right hemisphere damage perform significantly worse than patients with left hemisphere damage on visual closure tests (de Renzi & Spinnler, 1966; Warrington & James, 1967; Landsell, 1968; Newcombe & Russell, 1969). Similar investigations with commissurotomy patients have found that the left hand (by implication, the right hemisphere) of these patients is far superior in solving closure problems than the right hand (Nebes, 1971; 1972; 1973).

While there are obvious problems in attempting to generalize to normals from studies on brain damaged or commissurotomy patients, this evidence is at least suggestive of right hemisphere involvement in closure tasks.

Another line of work that relates hypnotizability to right hemisphere processsing is the research on lateral eye movements (LEMs). Working on the assumption that the characteristic direction of lateral eye movements is indicative of contralateral hemispheric activation (Kinsbourne, 1974), Bakan (1969) found that "right movers" were less hypnotizable than "left movers". Gur and Reyher (1973) found that "left movers" performed better than "right movers" on an induction scale with passive-emotional style instructions that called for focusing on internal, subjective events; while "right movers" performed better on an induction scale phrased in an active intellectual style that called for focusing on external events.

Further, Gur and Gur (1974) found that the relationship between LEM's and hypnotizability was moderated by sex, handedness and possibly eyedness. They reported correlations of -.68 and .58 between scores on the SHSS:C and right LEM's for right handed males and left handed females, respectively. Similar correlations for right handed females (.14) and left handed males (-.18) were not significant. There also appeared to be a sex × eyedness × handedness interaction in the study by Gur and Gur, but the number of cases in each cell was too small to permit adequate analysis.

Crawford (1976) also obtained a negative correlation (-.36) between right LEM's and the SHSS:C for right handed males. However, unlike the Gur and Gur (1974) result, the correlation for right handed females was also negative (-.41).

This presentation reports: 1) the results of an attempt to replicate Crawford's (1976) reported correlation between hypnotizability and speed of closure; 2) the results of a reanalysis of Crawford's (1976) data; 3) a new procedure for correcting correlations for bias introduced by non-proportional sampling.[1]

Past Research on Closure Abilities

Since a major portion of this paper deals with the relationship between hypnotizability and tests purporting to measure abilities called "speed of closure" and "flexibility of closure" it is useful to examine the factor analytic research regarding these constructs. This work began with Thurstone's classic factor analytic study of visual perception (Thurstone, 1944). In that study, three closure factors were tentatively identified. The first was called

"speed and strength of closure", but was actually more representative of spatial ability and did not appear in subsequent studies using less exotic tests (Thurstone, 1951; Botzum, 1951; Pemberton, 1952a).

The second closure factor seemed to involve freedom from what the Gestalt psychologists called Gestaltbindung, i.e., the inability to break one gestalt in order to form another. Thurstone dubbed this factor "flexibility of closure." PMA Reasoning, Hidden Pictures and the Gottschaldt tests (the source for Witkin's Embedded Figures Test and the ETS Kit Hidden Figures test) loaded heavily on this factor. However, the test defining the factor was called Two-Hand Coordination. It required the subject to tap the corresponding quartile segments of two non-symmetrically labelled circles at the same time. Quartile number one was centered at nine o'clock on the first circle and at 12 o'clock on the second circle. The other three quartiles followed in clockwise succession on both circles. The dependent measure for the test was a ratio of the number of simultaneous taps in corresponding quartiles using both hands and the sum of taps in each quartile using each hand independently.

"Speed of perception" is actually a misnomer for the third closure factor as it implies an ability similar to another well defined perceptual factor (perceptual speed). Thus, Thurstone later changed the name of this factor to "speed of closure" (Thurstone, 1951). The Street test and Mutilated Words are two tests which have consistently defined or loaded highly on this factor. It seems to involve the ability to synthesize discrete visual elements into a meaningful picture.

Replication of Thurstone's flexibility and speed of closure factors was provided in studies by Botzum (1951) and Pemberton (1952a). In the Botzum study, the five tests loading highest on flexibility of closure (Copying, Gottschaldt Figures, Designs, Block Counting and Paper Puzzles) were the same ones which defined the flexibility of closure factor for Thurstone's (1951) study of mechanical aptitude. However, in both of these studies the factor took on more of a spatial-analytic character and less of the "breaking of Gestaltbindung" displayed in the original Thurstone (1944) study. Botzum's speed of closure factor was defined by the Street, Backward Writing and Mutilated Words tests.

Similarly, Pemberton's (1952a) speed of closure factor was defined by Mutilated Words, Hidden Pictures and Gestalt Completion (an adaptation of the Street test). Pemberton's flexibility of closure factor was similar to those obtained by Botzum (1951) and Thurstone (1951) with Concealed Figures (an adaptation of the Gottschaldt Figures) and Copying defining the factor, and several reasoning tests loading significantly.

A much later investigation by Hoffman, Guilford, Hoepfner and Doherty, 1968) suggests a slightly different interpretation for the closure speed factor. In that study, the closure speed (or CFU) factor was defined by a test called Close Ups, followed by Figure Completion (an adaptation of the Street test), Hidden Print and Mutilated Words. In the Close Ups test, the subject must correctly identify a close up picture of a common object, such as a keyhole, a chocolate chip or a buttonhole. This suggests that the central aspect of closure speed may be the ability to recognize (or generate the remainder of) a visual stimulus when given incomplete information, not the ability to "close" a set of stimulus fragments.

Although he never directly investigated the hypothesis, Thurstone (1944) conjectured that perceptual abilities (especially speed and flexibility of closure) might relate to personality traits. Carol Pemberton (1952b) later confirmed her mentor's suspicions. She found that individuals with high scores on tests which loaded heavily on flexibility of closure regarded themselves as analytic, interested in scientific and theoretical problems, independent, and socially retiring, with an express dislike for rigid systematization and routine. On the other hand, those with high scores on speed of closure regarded themselves as sociable, quick to react, self confident, artistic, neat and precise. Further, they expressed a strong dislike for logical and theoretical problems.

These findings are important for attempts to conceptualize a general dimension of analytic-articulated vs. global cognitive style (Witkin et al., 1962). However, the search for generalized factors of speed and flexibility of closure that might relate to this cognitive style dimension has met with little success. Messick and French (1975) found evidence for a number of content-specific closure factors, but no evidence for independent general flexibility and speed of closure factors. In addition to reference factors, they obtained correlated first order closure factors

which they called flexibility of figural closure, speed of figural closure, verbal or symbolic closure, semantic closure, and a factor they tentatively labelled flexibility of grammatical closure. Second order factors labelled analytic functioning, figural closure, symbolic closure and semantic closure were also obtained. The second order figural closure factor combined the first order flexibility of perceptual closure and speed of perceptual closure factors.

Botzum (1951) also obtained a second order factor that combined the first order speed and flexibility of closure factors. However, flexibility of closure also loaded heavily on a second order spatial-analytic factor, while speed of closure had a large negative weight on a second order bipolar factor defined by first order factors for number, word fluency and verbal comprehension.

While Botzum's second order factors are indeed suggestive, the fact that first order factors for speed and flexibility of closure are correlated and thus define a second order factor in both the Messick and French (1975) and Botzum (1951) studies is troublesome for attempts to relate these factors to a general cognitive style dimension such as Witkin's (Witkin et al., 1962) or notions of cerebral laterality. While there are undoubtedly many reasons for this confusion, the following are likely candidates.

First, while the names of the factors have remained the same, their content has changed appreciably since the labels were first conferred by Thurstone (1944). Flexibility of closure was initially defined by tests which required breaking Gestaltbindung and also by Hidden Pictures and PMA Reasoning. In subsequent investigations, spatial ability tests gradually replaced the reasoning tests until, in the Messick and French (1975) study, they defined the factor. Thus, the factor has come to represent more of a spatial-analytic ability than Thurstone's flexibility of closure.

The major change in Thurstone's speed of closure factor has been an increase in the factorial complexity of the Street Gestalt, which usually defines the factor. Several investigators have found that the Street test has significant loadings on more than one factor (Pemberton, 1952a; Seibert & Snow, 19 ; Messick & French, 1975) and this has recently been shown also in some unpublished results from the Aptitude Project. In Thurstone's (1944) administration of the test, he used the number

of responses requiring three or more seconds as his dependent measure. Further, items were presented individually, with item exposure time and the distance between subject and picture controlled. Most subsequent investigations have employed a paper and pencil version of the Street Gestalt (or an adaptation of it) with total number right as the dependent measure. Exceptions to this general procedure are Crawford (1976), Seibert & Snow (1965) and the present investigation, where at least one closure speed test was presented on slides with item exposure held constant at 20 seconds per item. Paper and pencil adaptations of the Street Gestalt were also used in these studies.

While controlling item exposure time and distance between subject and test picture are improvements ove_ paper and pencil administrations, the dependent measure is still unsatisfactory.

Logic and post-test strategy interviews with subjects conducted recently by the Aptitude Project suggest that different abilities and strategies are called into play if the picture does not "pop out" at the subject within the first few seconds. Interestingly, one of the factors that becomes involved is flexibility of closure, in Thurstone's (1944) original sense of breaking Gestaltbindung. Some subjects report that if they think they see something in one part of the picture (or even the whole picture) that they know is incorrect, they have difficulty shaking that idea and imposing some other gestalt on the picture. Other subjects report having no difficulty in generating and testing a number of different ideas about the whole picture or parts of it.

Finally, using total number correct as the dependent measure brings in other problems. The distribution is usually positively skewed, and internal consistency of the test when scored this way is quite low. Discussion of these problems will be taken up later.

In sum, then, the tests used in prior research, and in this investigation, to measure flexibility of closure and speed of closure are deficient in several respects. Other research is presently being conducted that will hopefully clarify these deficiencies and the nature of ability and strategic variables that contribute to performance on these and other tests.

Since the present study was undertaken in an effort to replicate and extend Crawford's findings on the relationship between hypnotizability and speed of closure using test data already in hand, the tests were administered in the same format that she and other investigators have em-

ployed. While these administration procedures are not optimal, resolution of methodological issues raised by Crawford's sampling procedure necessitated a comparable administration. Therefore, though undesirable in one sense, standard administration of the tests was mandatory for meaningful comparison between the results of the two studies.

Method

The subjects were a sample of 19 females and 14 males from a population of 123 Stanford undergraduates participating in a larger experimental project on information processing analyses of cognitive abilities (Snow, Lohman, Marshalek, Yalow & Webb, 1977). Extensive psychometric information was available on all subjects, including two of the closure speed tests, both spatial ability tests,and the Hidden Figures test used by Crawford. Most of the reference tests were administered during February and March of 1976. The testing procedures and results of this reference bettery administration are discussed in detail elsewhere and so will not be repeated here (see Snow, Lohman, Marshalek, Yalow, & Webb, 1977).

Hypnotizability scores on the 33 subjects included in this study were obtained in one of two group administrations of a ten item adaptation of the Harvard Group Scale of Hypnotic Susceptibility (HGSHS; Shor & Orne, 1962). Administration was part of a separate testing program conducted during the fall of 1975 and winter of 1976.

Results

Total and within-sex correlations between the HGSHS and various tests in the reference battery are given in Table 1.

Insert Table 1 about here

The column labelled "Factor" identifies the factor or factors on which the particular test had significant loadings. These factors were obtained from a principal components analysis of the scores of the full sample of 123 Stanford students, and included all the tests in Tables 1 and 2 with entries in the factor column, plus Uses for Things and Film Memory III. Seven factors were retained and rotated to a varimax criterion. The sixth and seventh factors were singletons, defined by Uses for Things and Film Memory III, so factor scores were computed only for the first five factors. (For further information on the test intercorrelations and factor analysis, and a comparable analysis in a sample of 241 high school students, see

Table 1

Correlations of the Harvard Group Scale of Hypnotic Susceptibility with Various Cognitive Measures

Test	Factor	Total N=33	Male N=14	Female N=19
Sex		18		
Eyedness		-01	38	-35
Handedness		05	-07	15
Auditory Letter Span	IV	-05	06	-09
Visual Number Span	IV	-08	-01	-19
Identical Pictures	III,V	02	21	-10
Finding A's	V	-25	-37	-13
Number Comparison	V	11	-23	30
Street Gestalt	III	34	57	10
Picture Completion		06	03	-07
Harshman Figures	III	14	29	-07
Paper Folding	II,III	-06	-26	15
Form Board	III	05	-08	27
Surface Development	II,III	-06	-02	-13
Embedded Figures		09	01	25
Hidden Figures	II	-04	-03	-27
Necessary Arithmetic Operations	II	-06	-29	08
Thurstone Letter Series	II	-14	-01	-25
Terman Concept Mastery	I	-18	-28	-28
Word Transformations[a]	I	-28	-18	-40
Camouflaged Words[a]	I,IV	-38	-41	-39
Word Beginnings and Endings	I,IV	-15	15	-51
SAT Verbal	I	-04	10	-20
SAT Quantatative	II	02	06	-07
Adv. Raven Progressive Matrices		08	17	07
Uses for Things		39	47	33
Matching Familiar Figures		-29	-10	-47
Marks Imagery Questionnaire (VVIQ)[b]		09	00	44
Marks Imagery Test[b]		-15	-16	-08
Conry Picture Memory Test[c]		-23	-16	-24
Film Memory III[d]		02	02	01

[a] Guilford, 1967
[b] Marks, 1973
[c] Conry and Lohman, 1977
[d] Seibert and Snow, 1965

Note: Decimal points omitted

Snow, Lohman, Marshalek, Yalow, & Webb, 1977.) Correlations of HGSHS with these factors and with the subtests of the WAIS are given in Tables 2 and 3 respectively.

Insert Tables 2 and 3 about here

Because of the small sample size, (especially for the within-sex correlations) and the number of correlations involved, these results must be regarded as merely suggestive. However, a number of points are worth noting. First, sex appeared to be a moderating variable in a number of correlations. Eyedness (measured on a scale of 2 = strong right to -2 = strong left) correlated positively with the HGSHS for males and negatively for females. The Street test showed high positive correlation for males but a negligible correlation for females. On the other hand, the Marks Vividness of Visual Imagery Questionnaire (Marks, 1973) correlated positively with the HGSHS for females but showed no relationship with hypnotizability for males. Other variables giving strong differential correlations were: Word Beginnings and Endings (r=.51 for females, .15 for males); the information subtest of the WAIS (r=-.44 for males, -.05 for females); and the digit symbol subtest of the WAIS (.39 for males, .11 for females).

Other findings worth noting are (1) a positive correlation between Uses for Things and the HGSHS for both males and females (2) a strong negative correlation between total time to solution on Matching Familiar Figures (Kagan, 1965) and the HGSHS; and positive correlations between the Picture Completion and Object Assembly subtests of the WAIS and hypnotizability.

On a more general level, the usual finding that hypnotizability is not related to general mental ability was replicated: the correlation between the HGSHS and the full scale WAIS score was .04 for males and .07 for females. Going down the ability hierarchy one step, there were small positive correlations between hypnotizability and the WAIS performance scale scores, but slightly negative correlations with the WAIS verbal scale scores. A closer examination of the WAIS performance subtest correlations shows that this overall correlation was due primarily to the correlations of Picture Completion and Object Assembly with hypnotizability. These two subtests had their highest loadings on Factor III (Spatial

Table 2

Correlations of the Harvard Group Scale of Hypnotic Susceptibility with Ability Factors[a]

Factor		Total N=33	Males N=14	Females N=19
I	Verbal-Crystalized Ability	-21	-11	-37
II	Fluid-Spatial Analytic	-07	-23	-03
III	Spatial Vis-Closure Speed	24	29	18
IV	Memory Span	-08	-05	-15
V	Perceptual Speed	-11	-03	-06

[a]The factors came from a separate analysis on 123 Stanford students (Snow, Lohman, Marshalek, Yalow, & Webb, 1977).

Note: Decimal points omitted.

Table 3

Correlations of the Harvard Group Scale of Hypnotic Susceptibility with WAIS Subtests[a]

Subtest	Factor	Total N=33	Males N=14	Females N=19
Verbal Subtests				
Information	I	-17	-44	-05
Comprehension	I	01	-04	16
Arithmetic	II	06	23	-12
Similarities	(I)	-23	-11	-29
Digit Span	IV	-07	-12	00
Vocabulary	I	-05	15	-19
Performance Subtests				
Digit Symbol	V	21	39	11
Picture Completion	III	39	35	44
Block Design	II	-02	-16	-04
Picture Arrangement	(V)	-15	-15	-14
Object Assembly	III	28	27	30
Total Scores				
Verbal Scale Score		-13	-09	-13
Performance Scale Score		22	20	25
Full Scale Score		04	04	07

[a]The factors came from a separate analysis on the full sample of 123 Stanford students.

Note: Decimal points omitted.

Visualization, Visual Closure), the only factor which correlated positively with the HGSHS. The Harshman Figures and Street Gestalt were the tests loading highest on Factor III. Thus Crawford's contention that hypnotizability is related to speed of closure received some additional, albeit weak, support. The other four ability factors all had small negative correlations with HGSHS.

An interesting hint of sex differences emerged in the correlations with the factor scores. Factor I (verbal-crystallized ability) had a higher negative correlation with hypnotizability for females than males (-.37 vs -.11) while Factor II (fluid-spatial analytic ability) showed the reverse pattern--a higher negative correlation for males than females (-.23 vs -.03). Admittedly, these correlations and differences are small. However, the factor scores are based on a large number of tests and hence are much more reliable than any of the individual test scores. Thus, the small differentials here are as suggestive as much larger differentials in the raw score correlations.

Finally, a rather remarkable set of correlations between the California Psychological Inventory (CPI) and the HGSHS are presented in Table 4. In general, these correlations were much higher than those reported by Hilgard and Lauer (1962) for the same instruments. The obvious difference between this study and Hilgard's is sample size, so the high correlations obtained here may result from the anomalies of this sample. However, the fact that the correlations remain when computed within-sex argues against a casual dismissal on the basis of sample size.

Insert Table 4 about here

Finally, and most importantly, the results of this investigation are compared with those obtained by Crawford (1976). The unique characteristics of these two studies motivate this comparison: both were carried out on the same population (Stanford undergraduates); good estimates of intercorrelation among the reference tests for 123 students from this population were available, and a good estimate of the distribution of HGSHS scores in this population was available for 241 Stanford undergraduates. Thus, only the correlations between the hypnotizability measures and the common reference tests were particularly questionable, being based on 22

Table 4

Correlations of the Harvard Group Scale of Hypnotic Susceptibility with the California Psychological Inventory

Scale	Total N=33	Males N=14	Females N=19
1. Dominance	23	31	14
2. Capacity for Status	38	57	27
3. Sociability	44	46	44
4. Social Presence	40	70	09
5. Self-Acceptance	29	35	17
6. Sense of Well-being	29	21	42
7. Responsibility	14	29	14
8. Socialization	-20	-22	-12
9. Self-Control	10	07	25
10. Tolerance	42	56	37
11. Good Impression	30	26	44
12. Communality	-07	-16	-06
13. Achievement via Conformance	24	14	30
14. Achievement via Independence	48	58	41
15. Intellectual Efficiency	41	58	33
16. Psychological Mindedness	49	49	51
17. Flexibility	48	43	51
18. Feminity	15	30	18

Note: Decimals omitted

males and 20 females in the Crawford study and 14 males and 19 females in the present study.

Crawford (1976) reported correlations between the SHSS:C and the following tests: (1) Closure Speed (Thurstone & Jeffrey, 1966), (2) fourteen slides from Street Gestalt (Street, 1931), (3) twenty-two slides of the Harshman Figures (Harshman, 1974), (4) Paper Form Board, Surface Development, Hidden Figures, and Nonsense Syllogisms from the ETS Kit (French, Ekstrom & Price, 1963). All of the above tests except Closure Speed and Nonsense Syllogisms were included in the present study. Only those tests common to both investigations will be considered further.

Although Crawford reported correlations between the SHSS:C and the various tests, HGSHS scores were also available for all her subjects. Further, the SHSS:C and HGSHS correlated .95 in her sample (a value considerably higher than the .59 reported by Evans and Schmeidler, 1966). Since the HGSHS was used in the present study, and HGSHS and SHSS:C correlated so highly in the Crawford study, correlations between the HGSHS and the reference tests in the two studies were compared. Crawford's original correlations between the reference tests and SHSS:C are reproduced in Table 5 along with her unreported correlations with the HGSHS. Correlations with the HGSHS from this study are also listed in Table 5 for comparison.

Insert Table 5 about here

In general, correlations between the various reference tests and the HGSHS in the Crawford study are slightly lower than the corresponding correlations with the SHSS:C, although the differences are minimal. However, the differences between the HGSHS and reference test correlations in the Crawford study and the present investigation are substantial (comparing columns one and three in Table 5). For example, the most stable correlations in the table are those for the total sample (N=42 for the Crawford study and N=33 for the present study), and here the correlations reported by Crawford are consistently higher than those obtained in the present investigation.

Why the differences? The most obvious explanation is sampling error. However, the fact that there is a consistent difference between the correlations suggests that factors other than sampling error may be involved.

Table 5

Correlations between Hypnotizability and Tests Common to Crawford (1976) and the Present Investigation

Test	Crawford (1976) HGSHS	Crawford (1976) SHSS:C	Present study HGSHS
Total Correlations	N=42	N=42	N=33
Harshman Figures	32	40	14
Street Gestalt	48	53	34
Hidden Figures	12	13	-04
Form Board	12	16	05
Surface Development	17	22	-06
Females	N=20	N=20	N=19
Harshman Figures	30	32	-07
Street Gestalt	43	42	10
Hidden Figures	29	34	-27
Form Board	26	39	27
Surface Development	29	38	-13
Males	N=22	N=22	N=14
Harshman Figures	34	47	29
Street Gestalt	55	66	57
Hidden Figures	01	-02	-03
Form Board	01	-07	-08
Surface Development	07	07	-02

Note: Decimals omitted

The most important difference was in sampling techniques. Crawford selected 14 low (SHSS:C score 0-3), 14 medium (SHSS:C score 4-8) and 14 high (SHSS:C score 9-12) hypnotizable subjects; whereas in the present study the sampling was more or less random.

The second important difference was in test length. Crawford used only one form of the ETS Kit tests (Hidden Figures, Paper Form Board and Surface Development), whereas both forms of these tests were used in the present study. Crawford also used 14 slides from the Street test, while this study used only 11.

Methodological Considerations

The most striking difference between the two studies lies in their sampling procedures. The effect of non-proportional sampling in the Crawford study is seen in Figure 1, where distributions of HGSHS scores from the Crawford study and the present study are superimposed on the distribution of HGSHS scores for 241 Stanford undergraduates. The normative curve shows the bimodal character typically obtained with the HGSHS and other hypnotizability scales (Hilgard, 1968). The distribution for 33 cases in the present study approximates this curve rather well, considering the sample size. On the other hand, the curve for the Crawford data reflects her sampling procedure, and the proportion of observations with extreme scores (0, 1, 9, 10) is inflated.

Insert Figure 1 about here

The effect of this sort of non-proportional sampling procedure on the correlation of hypnotic susceptibility with other variables is reflected in its effect on the sample variance.

Table 6 shows the means and variances for the two studies and the normative group.

Insert Table 6 about here

The mean for the present study is slightly higher than the reference mean, while the variances are almost identical. The mean for the Crawford study is also close to the reference mean (5.4 compared with 5.3) but the variance is double that for the reference group. It is known that inflating the

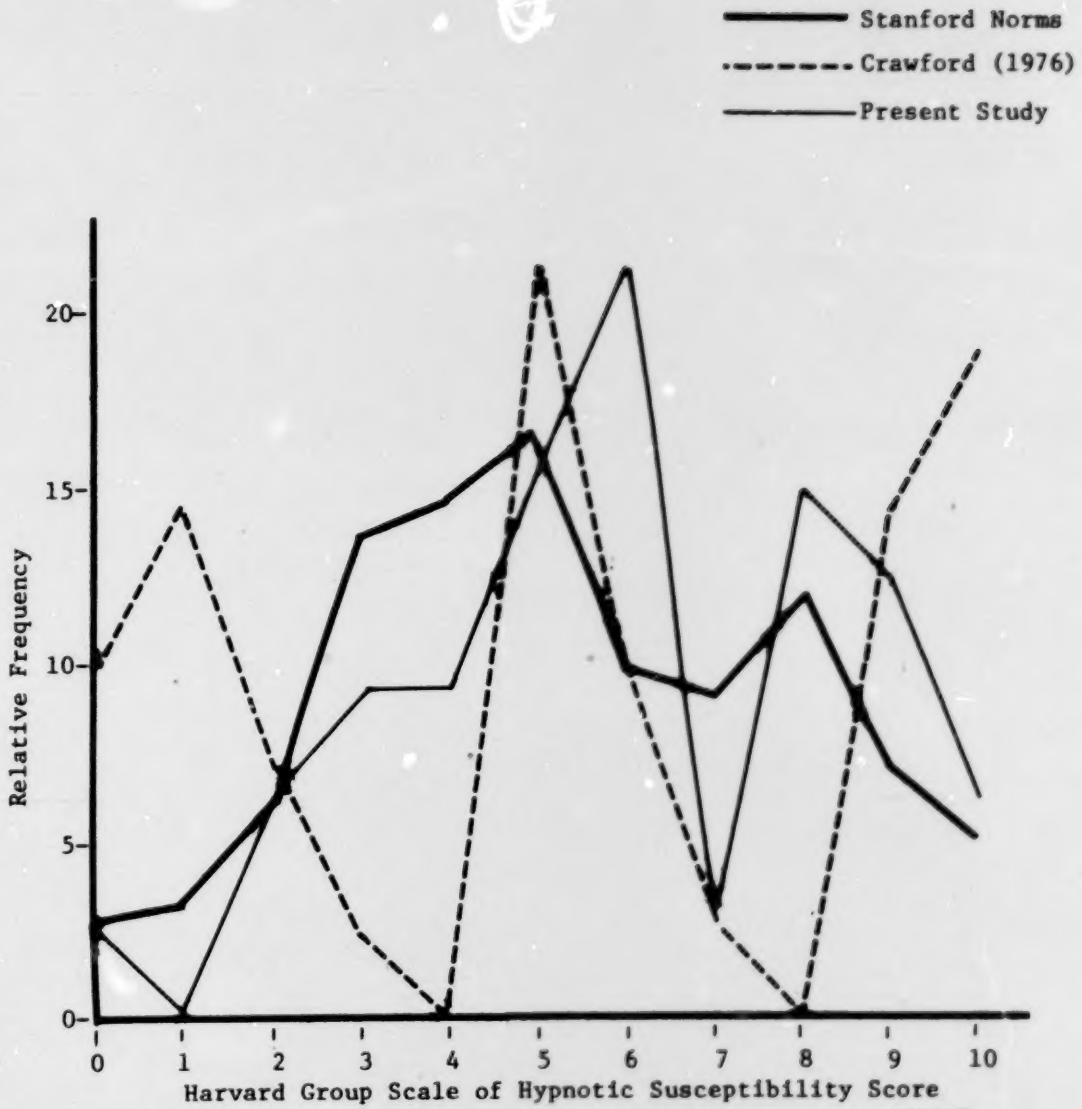

Figure 1. Distributions of Harvard Group Scale of Hypnotic Susceptibility scores for a normative Stanford sample (N = 241), Crawford, 1976 (N = 42), and the present study (N = 33).

Table 6

Means and Variances of Harvard Group Scale of Hypnotic Susceptibility Scores

Group	N	Mean	Variance
Normative[a]	241	5.3	6.34
Present study	33	5.9	6.27
Crawford (1976)	42	5.4	12.82

[a]Based on the results of administration of this scale to 241 Stanford undergraduates.

observed score variance also inflates the covariance, and hence, the correlation with any other variable.

The degree of inflation in the correlations may be estimated by applying the traditional correction for restriction in range to the inflated correlation. Although this correction is usually used to estimate the correlation in an unrestricted sample from a correlation obtained in a restricted sample (Cronbach, 1971; Gulliksen, 1950), it may also be applied where the reverse is needed, as in the present case.

The correction formula for the case where the variance of the variable subject to explicit selection is known for both groups is given by Gulliksen (1950):

$$R_{xy} = \frac{S_x r_{xy}}{\sqrt{S_x^2 r_{xy}^2 + s_x^2 - s_x^2 r_{xy}^2}} \qquad (1)$$

Where:

R_{xy} = the corrected correlation between x and y

r_{xy} = the observed correlation between x and y

s_x = the variance of the selection variable in the selected sample

S_x = the variance of the selection variable in the unselected sample

In addition to the usual assumptions of classical test theory, the derivation of this formula assumes that:

a) the regression of x on y is the same in the "restricted" and "unrestricted" groups, i.e., the mean y is the same for a given x.

b) the variance of y for a given x is constant at all levels of x, and equivalent in the "restricted" and "unrestricted" groups.

Taken together, these assumptions imply that the error of measurement is constant across all levels of x and the same in both the "restricted" and "unrestricted" samples. These assumptions are not ordinarily unreasonable. However, if the bivariate distribution departs significantly from normality, or either of the measures are particularly unreliable, the unrestricted correlation estimated by Formula 1 will be seriously biased. The coefficient will also be in error if any variable correlated with y (other than x) is used to screen one population and not the other.

Bivariate normality was checked by examing the scatter plots with HGSHS in both studies. There were a number of questionable plots, particularly the plots of Word Transformations and the Street test with

HGSHS in the present study, and the Street, Harshman Figures, and Paper Form Board plots in the Crawford study. Good estimates of the reliabilities for most of the tests were available from administrations of the tests to 123 Stanford undergraduates and 241 high school students. Reliabilities for the tests common to both studies are presented in Table 7. These coefficients are based on the combined high school and Stanford samples (N = 364). Coefficient alpha for the Street test was particularly low (.38), primarily because the first five items were too easy. Although a test-retest coefficient for this test would undoubtedly be higher, the error variance in the test is substantial. Hence, the assumption that the error variance is constant at all levels of hypnotizability in the regression of Street on HGSHS, and the same in both the "restricted" and "unrestricted" groups is highly unlikely.

Insert Table 7 about here

Finally, selection bias may be operating in both studies. Subjects who volunteer for hypnosis research are known to differ from non-volunteers in a number of ways and especially in hypnotizability. Volunteers are usually more hypnotizable than non-volunteers (Hilgard, 1968). The fact that subjects were paid participants in both experiments, and that Crawford deliberately selected an equal number of low, medium and high hypnotizables in an effort to insure that low hypnotizables would be adequately represented mitigates this complaint. Nevertheless, it is still possible that subjects who agree to participate in an experiment (especially an experiment on hypnosis) differ systematically from those who refuse to participate even when paid. If any of these differences correlate with performance on the reference tests, and if they were operative in the selection of one group and not the other, then formula (1) will again give a biased estimate of the correlation.

Since there were so many uncertainties about the possibility of satisfying the assumptions underlying the correction for restriction in range (Formula 1), an alternative procedure which assumed only that cases within each interval were randomly sampled was investigated. The procedure involved weighing the cases in each of Crawford's sampling intervals in order to make the distribution of HGSHS scores in her sample more like the normative HGSHS distribution for Stanford students shown in Figure 1.

Table 7

Internal Consistency and Parallel Forms Reliabilities for Tests

Test	alpha[a]	Parallel Forms	
		half test[c]	full test[d]
Street Gestalt	38[b]		
Harshman Figures	79		73
Hidden Figures	75	58	76
Surface Development	90	84	91
Form Board	80	69	82
Picture Completion	78	54	70

Note. All reliability estimates based on a combined sample of 241 high school students and 123 Stanford undergraduates except Picture Completion N = 106.

[a] A lower bound estimate on reliability. Negatively biased for speeded tests.

[b] This estimate is for the ten item test used in this study. An estimate for the 14 item test used by Crawford (1976) obtained by applying the Spearman-Brown formula to this estimate is .46.

[c] The correlation of part 1 of a test with part 2 of the same test.

[d] The part 1, part 2 correlation stepped up by Spearman-Brown.

In the first simulation, the proportion of cases in the normative distribution of HGSHS scores was determined for each of the sampling intervals used to select the subjects (i.e., 0 - 3, 4 - 8, 9 - 12). Integer multipliers were then derived for the Crawford sample, and each case in the sampling interval was multiplied by that integer. Correlations were then recomputed on this weighted sample. Computationally, this merely involved duplicating the appropriate computer cards, changing the number of cases parameter, and rerunning the correlation program. The percent of cases in the original, weighted, and normative samples for each interval are shown in Table 8. The percent of cases in each of the weighted sample intervals approximates those in the normative sample rather closely.

Insert Table 8 about here

The fact that there were no subjects with scores of four or eight on the HGSHS in this sample, and that these scores fell precisely on the selection boundaries complicates the weighting process. Should these points be considered part of the medium hypnotizability group? Or should they be omitted altogether from the weighting scheme? If they are included in the range of the medium group, then the multiplier is five (as in Table 8), and the effective N is 112; if not, the multiplier is three, and the percentages are as shown in Table 9, with an effective N of 84. Finally, if sampling intervals are ignored and the number of cases for each HGSHS score are weighted separately so as to mirror the normative distribution as closely as possible, the weightings are as shown in Table 10, with an effective N of 117.

Insert Tables 9 and 10 about here

Table 11 shows the correlations between HGSHS and the reference tests for each of these three weighting schemes, along with the correlations originally reported by Crawford (N = 42) and those obtained by applying the correction for restriction of range (Formula 1) to her correlations. The second weighting scheme, in which the medium hypnotizability group was defined as scores from five to seven (effective N of 84) produced correlations most similiar to those obtained from Formula 1.

Table 8

Number and Percent of Cases in each Interval for Original, Weighted and Normative Samples for Weighting Scheme #1

Interval	Original N[a]	Multiplier	Effective N	Percent	Norm Percent[b]
0 - 3	14	2	28	25.0	26.1
4 - 8	14	5	70	62.5	61.8
9 - 10	14	1	14	12.5	12.0
Total	42		112	100.0	99.9

[a]Crawford (1976)

[b]Based on HGSHS scores for 241 Stanford undergraduates

Table 9

Number and Percent of Cases in each Interval for Original, Weighted and Normative Samples for Weighting Scheme #2

Interval	Original N[a]	Multiplier	Effective N	Percent	Norm Percent[b]
0 - 3	14	2	28	33.3	35.4
5 - 7	14	3	42	50.0	48.3
9 - 10	14	1	14	16.7	16.3
Total	42		84	100.0	100.0

[a]Crawford (1976)

[b]Based on scores for 241 Stanford undergraduates on the HGSHS, omitting scores of 4 and 8.

Table 10

Number and Percent of Cases for each Score in Original, Weighted and Normative Samples for Weighting Scheme #3

Score	Original N[a]	Multiplier	Effective N	Percent	Norm Percent[b]
0	4	1	4	3.4	2.9
1	6	1	6	5.1	3.3
2	3	3	9	7.7	6.2
3	1	21	21	17.9	13.7
4	0	-	0	0.0	14.5
5	9	3	27	23.1	16.6
6	4	4	16	13.7	10.0
7	1	14	14	12.0	9.1
8	0	-	0	0.0	11.6
9	6	2	12	10.2	7.1
10	8	1	8	6.8	5.0
Total	42		117	99.9	100.0

[a]Crawford (1976)

[b]Based on HGSHS scores for 241 Stanford undergraduates.

Defining the medium group to include scores of four and eight (effective N of 112) produced slightly lower correlations, with the largest discrepancy being in the correlation of the HGSHS with the Street test. Given the low alpha for this test, and the questionable plots, this result is hardly surprising. In this case, the correlation obtained from the weighting scheme is undoubtedly a better estimate than that obtained through the application of the correction formula.

Insert Table 11 here

In general, however, the degree of concurrence between the results of the weighting schemes and the correction formula are indeed remarkable. This suggests that, for correlations of this magnitude, violation of the assumptions underlying Formula 1 must be rather substantial before any truly noticeable effect on the resulting correlation occurs. Larger correlations would be more sensitive to assumption violations.

The weighting schemes also had systematic effects on the variance estimates. The variance of HGSHS scores decreased with increases in the effective N, but did not quite reach the normative value of 6.34, even when each score was weighted individually as in the third scheme. For the reference tests, however, variances tended to increase with increases in the effective N. Again, the third weighting scheme (N = 117) produced some anomalies. This is hardly surprising considering the fact that some cases were weighted far more than others. Because of this, the other weighting schemes seem preferable; less reliance is put on any one score, and the assumption that scores within a range were randomly sampled is more tenable than the assumption that one or two scores at a particular level were randomly sampled.

Integer values were used in all the weightings, more out of convenience than necessity. The computational routines employed would have required an unequal weighting of the cases within an interval if non-integer weights had been employed. This is effectively what was accomplished by weighting each level separately (N = 117), and the results were trivially different from those obtained by the second integer weighting scheme (N = 112).

Table 11

Original and Adjusted Correlations between the HGSHS and Reference Tests

Test	Crawford (1976)	Weighting Scheme 1	2	3	Corr. for R.R.[a]
Harshman Figures	32	22	26	27	23
Street Gestalt	48	27	35	28	36
Form Board	12	07	08	17	09
Surface Development	17	08	09	19	12
Hidden Figures	12	06	07	15	09
Closure Speed Test	43	30	35	41	32
Sum of Closure Tests[b]	47	30	36	37	35
Effective N	42	112	84	117	

[a]Correlation in column 1 after correction for "restriction" of range by Formula 1.

[b]Direct sum of each student's scores on the Street, Harshman Figures and Closure Speed tests as reported in Crawford (1976).

Note: Decimal points omitted

Discussion

The most important conclusion of this investigation is that the relationship between speed of closure and hypnotizability is not of the magnitude originally reported by Crawford. Nevertheless, there does seem to be a correlation here worth pursuing. It appears that the relationship is moderated by sex. The correlation between hypnotizability and speed of closure was much higher for males than for females in both Crawford's study and the present investigation. However, there were only 22 males in the Crawford study and 14 in the present study. The Street Gestalt had particularly high correlations with the HGSHS score for males in both studies. On the other hand, correlations with the Harshman Figures test were much lower. This suggests that the high correlation between the Street Gestalt and the HGSHS may be an artifact of the unreliability of the Street test. However, it may also indicate that the Street test is a better measure of some aspect of closure speed than the Harshman Figures.

Some further comments are in order on the nature of the speed of closure tasks employed in these studies and the magnitude of the correlation that can reasonably be expected to occur when using them. It was noted earlier that the tests are factorially complex and that administration procedures have undergone subtle but significant changes since Thurstone (1944) first used them to isolate a factor he called "speed of closure". Changing the dependent measure from "number of responses requiring three or more seconds" to "total number correct" introduces other ability and strategic variables. Of particular importance is the possibility that flexibility of closure may influence performance, since in both Crawford's study and the present investigation one of the tests (Hidden Figures) which usually defines or loads heavily on this factor had no relationship (and possibly a negative relationship) with hypnotizability. Thus, correlation between the speed of closure measures and hypnotizability would be attenuated by flexibility of closure when using the tests in this way. Using response latency in addition to correctness as a continuous dependent measure would be preferable to Thurstone's (1944) technique, since calculating within-person regressions no longer carries the computational burden it did in Thurstone's day.

Lack of control over item exposure time and response latency for individual items are serious limitations in the usual paper and pencil version of the Street, or adaptations of it. Distance between the subject and the stimulus display is also left uncontrolled by such a technique, and distance has been found to be a critical determinant of item difficulty. Within the bounds of visual acuity, increasing the distance between the subject and the stimulus (or, conversely, decreasing the size of the image) reduces item difficulty.

Finally, intercorrelations among these various speed of closure tests (Street, Harshman Figures, Gestalt Completion and Picture Completion) are quite low, considering the fact that they are essentially all parallel forms of the same test. For example, in an administration of these tests to 123 Stanford students, the Street test and Harshman Figures correlated .61, the Street and Picture Completion .43, and the Harshman Figures and Picture Completion .56. The first correlation is inflated by both method and occasion variance, since both were slide presentations on the same testing session. The latter two correlations are across method and occasion, as the Picture Completion is a paper and pencil test that was administered in a separate testing session approximately two months later.

Internal consistency of the tests is also quite low (see Table 7 and Guilford & Lacey, 1947 for comparable intercorrelations and internal consistency estimates). In large part, these coefficients reflect the fact that the Street test and the Picture Completion tests were too easy. This is shown graphically in the total score distributions for these tests in Figure 2. However, the meager internal consistency coefficients may also reflect other uncontrolled sources of item variation in the tests. In addition to the factors already mentioned, variables such as the number of picture parts presented, distances between them, and object familiarity all float freely in these tests. Lumping these factors together under the title of "item difficulty" does not clarify matters. Factorially designed tests, where these and other dimensions are varied systematically would greatly improve our understanding of these measures and the psychological processes they reflect. Factorially designed experiments with factorially designed tests would also yield a breakdown of the total test

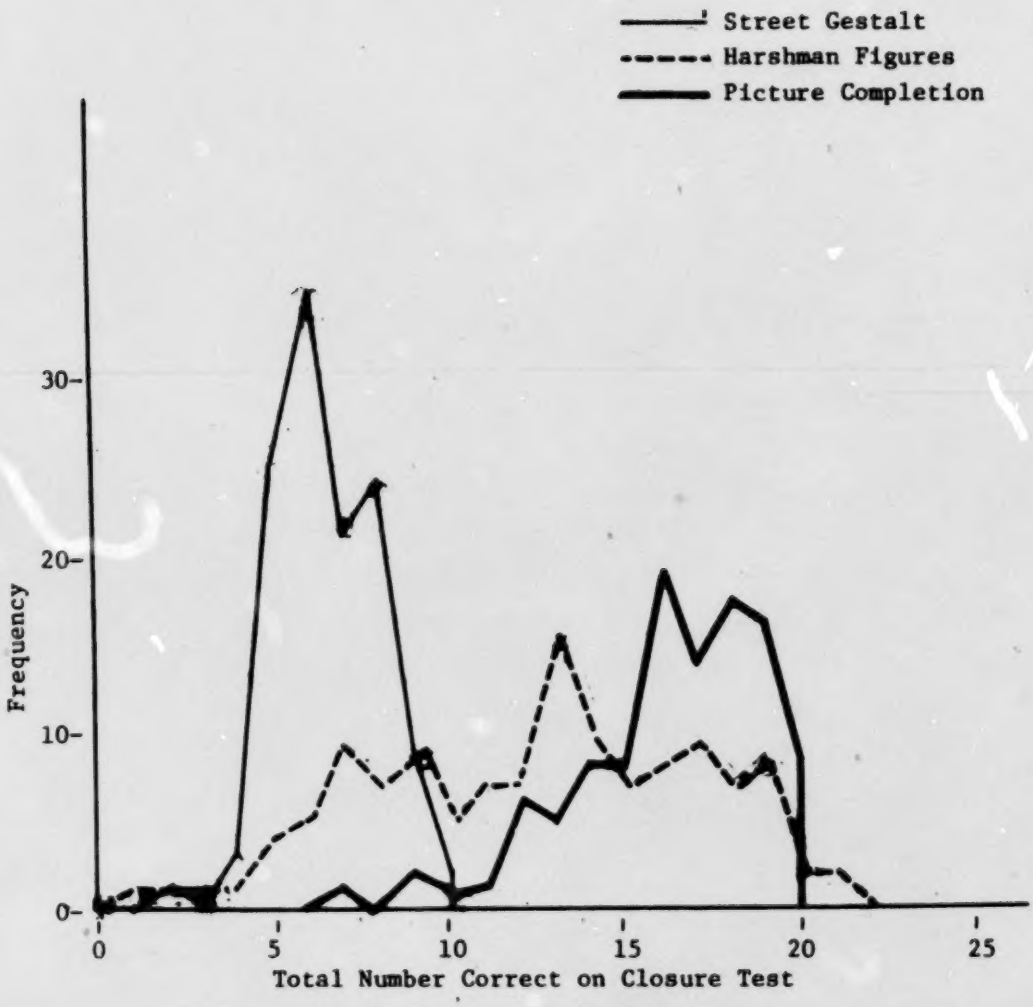

Figure 2. Distributions of total scores on the Street Gestalt (N = 122), Harshman Figures (N =123), and Picture Completion (N = 105) tests.

variance into the design components, and thus allow proper disattenuation of the resulting correlations.

Insert Figure 2 about here

As Cronbach (1971; see also Cronbach, Gleser, Nanda, & Rajaratnam, 1972), has pointed out, one is rarely interested in the observed correlations in theoretical work. The real question of interest is what is the relationship between hypnotizability and speed of closure ability, not what is the relationship between this particular test of hypnotic susceptibility and these particular tests that in part measure something we call "speed of closure". Disattenuating correlations for error of measurement has been considered suspect in some circles, primarily because the procedure has been misunderstood and misapplied too often in the past. The sources of this confusion are twofold: (1) uncritical application of the correction without regard for the assumptions involved, (2) inadequate estimates of the variance components entering the reliability estimate, given the universe of generalization. The latter error can lead to misleading or impossible results, as when a disattenuated coefficient greater than one is obtained. The correlations presented here were not disattenuated for precisely these reasons. On the other hand proper application of disattenuation procedures could greatly facilitate understanding of the relationships involved.

Finally, latency and correctness of response should not be confounded as they are in a time limit test where total number correct is used as the dependent measure. Speed and power appear to be largely independent aspects of performance, particularly in the visuo-spatial domain (Tate, 1948; Egan, 1976). It would appear that the most promising univariate dependent measure for closure speed tests would be the speed of correct responses, not the total number of correct responses. Nevertheless, both aspects of performance should be measured and related to the facets of the factorially designed test.

Summary

Many trait theorists have argued against the artificial separation of ability and personality constructs. However, attempts to relate the highly stable trait of hypnotizability to either personality or ability constructs have been particularly unsuccessful (Hilgard, 1968). Thus

the report by Crawford (1976) of substantial correlations between hypnotizability and various speed of closure measures signalled an important breakthrough.

An attempt to replicate those correlations on the same population in the present study yielded markedly lower correlations. A closer inspection of Crawford's study revealed that non-proportional sampling had spuriously inflated the earlier reported correlations. Application of the traditional correction for restriction of range to Crawford's data yielded correlations quite similar to those obtained in the present investigation.

However, possible violation of several of the assumptions which underpin the traditional correction prompted the development of a new technique to correct an inflated correlation. The procedure assumes only that cases within a sampling interval were randomly sampled from that interval. Scores within each interval are weighted in order to modify empirically the distribution of scores to reflect the normative distribution.

Application of this technique to Crawford's data yielded correlations quite similar to those obtained when the traditional correction for restriction of range was applied. It was concluded that, especially for small correlations, violation of the assumptions for the traditional correction must be quite severe before any noticeable effect on the corrected correlation occurs.

Finally, it was argued that there probably is a significant relationship between closure speed and hypnotizability although not of the magnitude reported by Crawford. It appears that the relationship is much higher for males than for females, although the within sex sample sizes in both studies were too small to permit adequate analysis.

Future research in this area would profit from a clarification of the psychological processes involved in closure speed. Factorially designed tests, in which item exposure is controlled and stimulus features are systematically manipulated would constitute an important first step in this direction. Using both latency and correctness as dependent variables in such an analysis is also strongly recommended.

Footnote

1. The author is indebted to Dr. Helen Joan Crawford for permission to reanalyze her data, and for supplying the Harvard Group Scale of Hypnotic Susceptibility scores for the students participating in this study.

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